

Guide to Reducing Energy Use in Office Equipment

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Electronic versions of this guide and the additional resources are available on the Internet at <http://eetd.LBL.gov/BEA/SF/>.

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Chapter 1 - Introduction

This Guide and the associated resources will lead you step by step through the development and implementation of a program to reduce electricity use in your organization. Our focus is on the office *plug load* – devices plugged into the wall. Although a wealth of information exists for conservation programs that address lighting and space conditioning, there is a dearth of practical information on how to increase overall efficiency of office equipment. This guide is intended to fill that gap. It is intended to be used by motivated individuals to make changes in their own organizations; no specific technical background is assumed.

We estimate that one workstation (computer and monitor¹), if left on after business hours and without automatic power management, produces nearly one ton of CO₂ per year². This is five times the amount produced if the workstation is switched off at night and engages power management during idle periods in the day. If everyone in the U.S. were to turn off their equipment at night, the nation could shut down eight large power stations and save 7 million tons of CO₂ every year. One estimate (Koomey et al., 1995) is that without power management, electricity for PCs and monitors would cost U.S. businesses about \$1.75 billion per year in the year 2000.

This Guide is based on a study of office equipment in City of San Francisco offices in 1997 and 1998. We found that implementing an energy conservation program is surprisingly inexpensive, given the potential energy savings. We also found that even the easiest and least expensive measure—sending emails requesting employees to turn off their equipment at night—can produce significant savings. In the municipal offices of San Francisco, comprising approximately 12,000 workstations, the plug loads we identified are estimated to use about 8.5 million kWh per year. The potential savings we identified are about four million kWh per year for the entire city. At a national average cost of \$0.08 per kWh, this is a savings of about \$300,000 per year. This assumes that all offices can be reached, as well as 100% participation, so that actual savings will be less, but it does indicate the magnitude of achievable savings.

We take three approaches to reducing electricity use: encouraging users to turn off equipment at night; enabling the power management features found in ENERGY STAR equipment; and influencing office equipment purchasing.

This Guide begins with background information about the office plug load, the ENERGY STAR program, and major issues in reducing office electricity use. The second chapter addresses estimating your organization's potential energy savings. The third chapter discusses general issues for designing a conservation program. The fourth chapter details the elements of the program.

Additional software and other resources to assist you in implementing a cost-effective program are available on the Internet at <http://eetd.LBL.gov/BEA/SF>. These are an integral part of this guide.

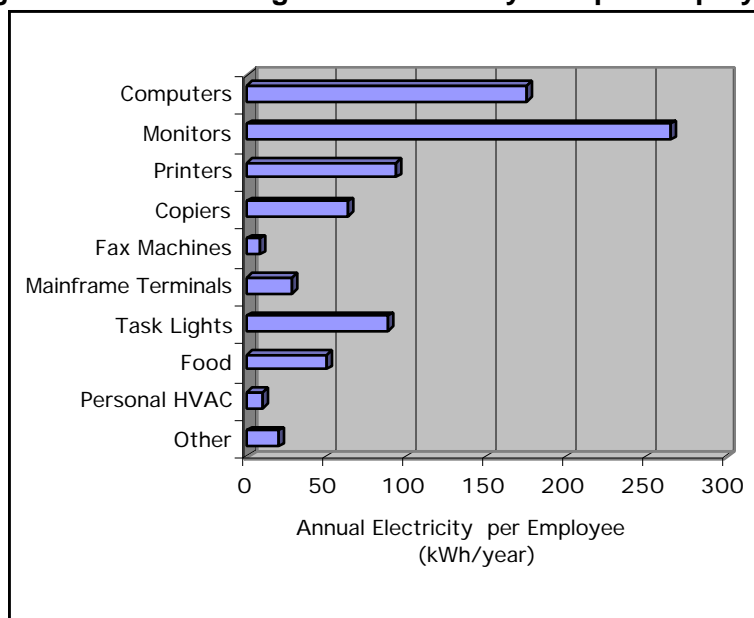
¹ The term 'workstation' is used to mean the office equipment dedicated to one person. As a few people in an office setting may have no computer, there may be fewer workstations than people. Few people in San Francisco have more than one computer, and the majority of these are IS staff.

² Based on 1.35 lbs CO₂/kWh. This is a rough national average figure for the U.S.

Electricity Use of Office Equipment

Figure 1 illustrates the annual electricity use for equipment commonly found in offices and plugged in to wall outlets. These estimates are based on surveys in City of San Francisco offices representing about 1,000 employees. Most of the office plug load is office equipment, so that is the focus of this guide.

Figure 1 – Annual Plug Load Electricity Use per Employee



Other: The miscellaneous plug load includes a myriad of devices, including typewriters, adding machines, microfiche readers, clocks, timeclocks, water coolers, and radios. While 'office equipment' is a useful term to use, it is worth keeping these other devices in mind.

The electricity used by office equipment can rival that used in office lighting. Lighting is widely recognized as a major energy use with significant potential savings in most buildings. Office equipment deserves the same level of attention.

Our main concern was the possible energy savings in plug loads, and we found a considerable potential. Following are some of our other findings about office equipment electricity use:

- Despite diverse uses, the power that computers and monitors draw while in use varies only moderately between machines. Annual energy use varies mainly with hours of operation and success in power managing.
- Printers, copiers and fax machines do vary widely in power consumption and in the number of staff sharing each device. Only a minority of printers and copiers are manually turned off at night, though many have functioning power management, saving energy off-hours.
- Some offices have unique, significant features. An example of this is the mainframe computer terminals still found on a majority of desks in some San Francisco departments (though they are completely absent in most). Terminals are frequently left on at night and can rarely power manage.
- In many offices, task lighting is increasing due to the installation of workstation systems. Task lighting merits watching due to its potential rapid growth.
- Food storage and preparation appliances in the standard office kitchen do not contribute greatly to annual electricity use. Occasionally an office shows a proliferation of refrigerators and cooking devices in individual workspaces; this can become important for electricity use.

- In some offices, many employees have individual extra heaters, fans, and occasionally humidifiers or air filters. These can use significant energy and are signs of problematic ventilation systems.

Beyond the direct electricity benefit of reduced plug load electricity, it will also cause a decrease in electricity used for air conditioning, may reduce ‘peak load’ electricity costs, and can avoid reaching the limits of outlet wiring in older office buildings.

While not a direct use of electricity, the paper used in office equipment (copiers, printers, and fax machines) is similar in many ways to office equipment electricity use, and so a logical part of a comprehensive program. The average office worker uses 10,000 sheets per year of office paper, which is the energy equivalent of 80 Watts of electricity used during work hours, or 160 kWh/year. At half a cent per sheet, it is \$50 per person per year. Significant cost-effective opportunities exist to reduce this.

ENERGY STAR Equipment



The U.S. EPA/DOE ENERGY STAR program was created in 1992 to increase the energy efficiency of common office equipment. Most computers, monitors, printers, and copiers now made are ENERGY STAR compliant, as are many fax machines and some other devices.

The features mandated by the program involve automatic *power management*, whereby an unattended machine will reduce its power or even turn itself off. A computer’s power management circuitry controls its own power usage, and it also signals the monitor to enter low-power states. See the ENERGY STAR web site (<http://www.epa.gov/office>) for further information about the program.

Most new equipment in today’s business and institutional offices is ENERGY STAR compliant. As equipment becomes obsolete and is replaced, the number of non-ENERGY STAR devices is diminishing. The major exception to this trend is laser printers; frequently a shared printer, upon replacement, is moved into an individual’s office as a personal printer. ENERGY STAR equipment can save up to 75% of the total electricity use, depending on the type of device and usage patterns. ENERGY STAR copiers that make over 44 copies per minute must have the ability to be set to “default duplex” copying, to reduce paper use.

Savings Potential: Better User Behavior and Equipment

The two factors which are the core of our office equipment program are: users who leave their equipment on at night, and ENERGY STAR equipment that fail to engage their power management features. We found that about a third of computers and monitors are left on at night, and about two-thirds of printers and copiers are not switched off.

Encouraging users to turn off equipment at night

Common misconceptions account for much of the failure to turn off equipment. Many people (including Information Systems staff) believe that equipment will last longer if it is never turned off. This incorrect perception is a relic from the days of mainframe computers and early microcomputers, when hard drives and circuitry were made differently and best left on; this is not true for current equipment.

Many users simply follow the prevailing behavior pattern of leaving equipment on. They may only need to be reminded that turning off their equipment will save money and reduce pollution. It is important to recognize that some computers do legitimately need to be left on, for such purposes as remote access, provider network services to other computers, or for data backup. In these cases, monitor power management can still be enabled, and many of these PCs can still be

enabled for power management, or even automatically shut themselves off (e.g. after the backup completes).

In most offices, there is no individual responsible for turning off shared equipment, such as printers and copiers at the end of the day. Workers in large offices may be reluctant to turn these off if they are uncertain whether someone else is still working. For these reasons, power management features are a more fruitful method of reducing their electricity use than the 'turn-off' programs applicable to PCs and monitors, but personal printers (more likely to be non-ENERGY STAR) should still be manually switched off. In the San Francisco offices, shared office equipment consumes about half as much electricity as personal computers and monitors.

Enabling power management features

The disabling of power management usually occurs during machine setup, or in an attempt to fix a problem. Although the ENERGY STAR program requires that equipment be shipped with power management working, it is routinely disabled by many equipment installers.

In most cases, PC power management operates without causing the user any problems. When problems do arise, it is mainly with older PCs and certain operating systems. Certain combinations of hardware and software can also cause problems with power management. Some network cards and networking software cause network connections to drop, and some older software can cause a machine to freeze while it is in low-power mode. While these problems are not common, when they arise they tend to generate considerable extra work for IS (Information Systems) staff. The memory of such trouble causes some IS professionals to routinely disable power management to prevent possible conflicts.

Monitor power management lacks such problems. As a monitor consumes about twice as much electricity as the PC, a significant portion of ENERGY STAR savings can be gained from enabling monitor power management alone.

Microsoft's Windows NT (version 4.x and earlier) presents a significant impediment to power management in many systems. This operating system does not support independently setting monitor power management, and usually prevents any power management (PC or monitor) from operating. Windows NT 5.0 will supposedly overcome these problems when it is released. With Windows 95, 98 and Macintosh operating systems it is possible to separately invoke monitor power management.

Power management in copiers, printers and fax machines is not known to cause technical problems or fail to function when enabled. Although power management for printers and fax machines has a negligible effect on users, for present-day copiers the warm-up time can be irritating to some, which may require extending power management delay times.

In most cases where power management is not operating, it is simple to reconfigure the machine. However, for computers this should be done in cooperation with IS staff due to the possibility of legitimate technical concerns. Some copiers require the service technician to enable power management or even check the configuration; in others, the 'key operator' is needed.

Chapter 2 - Estimating Plug Load and Savings Potential

This chapter will assist you in determining electricity use and savings potential for your office plug load. We present three levels of estimation. The simplest requires one minute with a calculator and is described below. A more refined estimate is made with a spreadsheet tool *Plugload.xls*, and is described in the next section. The most detailed estimate requires performing your own after-hours facility audits. While these are not required for designing a conservation program, they can be helpful, to justify a program, and to better understand the savings potential.

A First Estimate

The simplest estimate of savings potential requires only that you scale our findings to your organization, and insert your local electricity rate:

Potential annual savings (\$)

$$= 330 \text{ kWh/year} \times \text{office stations} \times \$\text{_____/kWh}$$

This estimate assumes that your organization's distribution of equipment types, user behavior, and rate of proper power management configuration are the same as found in San Francisco.

Table 1 provides the figures that go into the above savings estimate. Displayed are the estimated current use and potential energy savings per workstation, based on the patterns of user behavior and configuration we found. In addition to the electricity figures show here, the office paper used by the typical office worker embodies the equivalent of 160 kWh/year, which should be easily reducible by 10 to 30%. On an energy basis, paper is considerably more expensive than electricity, so the dollar savings with paper are greater than the energy savings indicate.

Table 1 – Current Electricity Use and Potential Savings (kWh/year per workstation)

Equipment Type	Current Use	Savings from Conservation Measures			Potential Use
		Turn Off at Night	Configure Properly	Both	
Computers	177	80	31	91	86
Monitors	250	114	71	134	116
Printers	93	51	6	52	41
Copiers	63	15	6	15	48
Fax Machines	8	n.a.	0	0	8
Mainframe Terminals	27	15	n.a.	15	12
Task Lights	88	22	n.a.	22	66
Total	706	298	117	339	367

The *potential* savings shown here assume perfect success in modifying user behavior and configuring equipment, of the current stock of computers. The total savings are less than the sum of behavior and configuration savings, due to the considerable overlap of the two measures. The

realizable savings will be smaller due to technical, institutional and human barriers found in any large organization. However, a comprehensive program should be able to approach these potential savings.

After making this first calculation you may have a sufficient rationale to design your conservation program, so can proceed to Chapter 3. To refine this estimate to reflect your organization's situation, continue with this chapter.

A Refined Estimate: Adjust for Local Conditions

The spreadsheet *Plugload.xls* allows more refined estimates of office machine electricity use, cost and savings potential. The spreadsheet allows you to test possible scenarios, based on the conditions at your sites. Explore the spreadsheet and get a feel for what inputs are needed; the following sections will assist you in estimating your office characteristics.

The best sources for information about equipment holdings are usually IS (Information Systems) managers, vendors (if services are outsourced), or property managers. The questions in *ISSurvey.doc* will provide information about the age and status of computers and printers, any known problems with power management, and knowledge and attitudes of the IS staff. Copiers and fax machines are more commonly controlled through traditional administrative channels.

Number of Machines

Determining the number of office stations can be a formidable task in an organization with many diverse departments. Sources to ask about equipment holdings include: purchasing departments, Information Systems divisions, and equipment inventory managers. An equipment vendor with a long-running relationship with your organization may have better records than in-house staff.

Table 2 shows the average count of equipment of various types in a sample of San Francisco municipal offices. While the prevalence of desktop computers varies little among departments, the reverse is true of mainframe terminals. We found many cases of newer PCs alongside old terminals, because both systems are in use as modern hardware and software are phased in. The impact printers that we found are associated almost exclusively with mainframe systems.

Table 2 - Average Machine Counts in San Francisco Municipal Offices

Device Type	Count Per 100 Office Staff	Device Type	Count Per 100 Office Staff
Desktop PC	88	Copier	4
Laptop PC	4	Fax Machine	3
Monitor	90	Laser Printer	16
Mainframe Terminal	25	Impact Printer	3
		Inkjet Printer	1

The number of shared devices per 100 staff (printers, fax machines, and copiers), depends on office size. The number of users who can share a printer or copier reaches a practical limit of 20 to 50. However, an isolated office needs these devices even if only a handful of people work there. A further complication is that some offices retain old printers and fax machines even after they have been replaced as shared devices, converting them to personal use.

We found the percentage of equipment that was ENERGY STAR compliant to range from just above 40% for printers and fax machines, to over 70% for computers and copiers, and nearly 90%

for monitors (averaged across all sites). The comparable figures for your offices depend in part on the average age of your machines. Market penetration of ENERGY STAR equipment has risen sharply since the program was begun, so that the newer the stock of equipment, the more likely that it is predominantly ENERGY STAR compliant.

User Behavior

Through night-time audits, we estimated the fraction of computers, monitors and printers left operating after business hours. The fraction of computers left on at night was found to average near 30%, and range as high as 70%. Rates near 20 to 25% were found where some prior user education had been done. Persistent in-house conservation advocates were able to achieve a 10 to 15% rate despite some resistance from misinformed IS staff. An office with a mandatory nightly server logoff for data backup produced a similar result. An office with a program of individual training, including a mandate to shut down nightly, produced about a 5% leave-on rate; a similar rate was observed in an office with a high level of environmental awareness.

Impediments to evening shutdown include difficulty of login, lengthy virus scans at startup, and IS staff who discourage shutdown due to persistent beliefs that equipment lifetimes will be shortened. Shared printers and copiers are not commonly turned off manually; we found 70 to 100% left on, except in the environmentally oriented office noted above, where the rate was 30%.

Proper Configuration of ENERGY STAR Equipment

The fraction of ENERGY STAR computers, monitors and printers which are properly configured for operation of their power management features we found were about 40% for computers, 55% for monitors, and 70% for printers (the computer figure may be higher, but many PCs do not indicate power management status externally). All the copiers and fax machines we examined had power management enabled, though a larger study (Nordman et al., 1998) found almost 40% of copiers at least partially disabled, and the number of fax machines actually examined in our study was small.

Several factors affect the successful operation of power management:

- **Equipment Age.** Some early ENERGY STAR PCs were shipped with power management disabled.
- **IS Management.** Some well-informed, conscientious IS staff perform routine PC maintenance and include power management. Others always disable power management upon installation. Most lie somewhere in between, enabling or disabling power management only in response to requests or problems.
- **Vendor Installation Practices.** Manufacturers' and vendors' representatives sometimes disable power management as a matter of standard procedure when they perform installation and training at the customer site.
- **Hardware and Software Conflicts.** Infrequently, operation of internal power management causes problems with installed hardware, software, or networks. Windows NT (version 4.x and earlier), does not recognize power management, so configuration must be done in the system BIOS. This usually prevents the use of monitor power management in cases where the computer's internal sleep modes cause conflicts, and defeats PC power management entirely.

For ENERGY STAR compliant equipment, we found that, on average, power management was clearly operating successfully in just over 40% of computers. In one large office, no machines were engaging these features, indicating that IS staff had disabled them as a matter of policy. Roughly 70% of printers, and nearly all copiers, were successfully engaging power management. A few non-ENERGY STAR printers and copiers showed power management capability.

Adapting our Results to your Organization

After some experimentation with *Plugload.xls*, you should be able to estimate your savings potential and your uncertainty with it. You are now ready to investigate conservation program design issues in the next chapter. The rest of this chapter concerns detailed site audits, which may not be needed before designing a program. Site audits may be indicated if the uncertainty in your savings potential estimate is too large for your taste, or if measurement of success is a priority. A discussion of how to conduct office equipment audits is available from the web.

Office Equipment Energy Audits

The *Plugload.xls* spreadsheet allows you to estimate the office equipment energy use from your own audits rather than using San Francisco results. This is appropriate if your organization seems to be markedly different from San Francisco. You may find it helpful to audit a few sites to better assess the state of machine configuration and user behavior, and to identify any special circumstances. A set of “baseline” audits combined with follow-up audits allows you to accurately judge the effectiveness of your program.

After-hours audits help determine the fraction of equipment in full power, in low-power modes, and off, as well as whether equipment are ENERGY STAR compliant or not. A pair of auditors can efficiently cover 300 or more workstations in an evening walk-through of three hours. An evening audit of computers and monitors can proceed within an hour after the workday ends, as most power management timeouts are an hour or less. For printers and copiers, however, two-hour timeouts are common, so a later starting time or a return sweep is needed for these equipment. It is preferable for printers and copiers to directly check the configuration.

If you are conducting a set of audits for a diverse organization, it pays to consider selection effects. For instance, using IS management to gain access to sites may provide biased sampling. The IS staff who are cooperative tend to be the ones who do not disable power management, whereas the staff who are not helpful are more likely to be at those sites where a conservation program is most needed. Key to obtaining dependable pre-program audit information is that the site staff not be “tipped off”. It is helpful when obtaining access permission to assure the site managers that audits are for the purpose of organization-wide evaluation, not for judgment of the particular site staff.

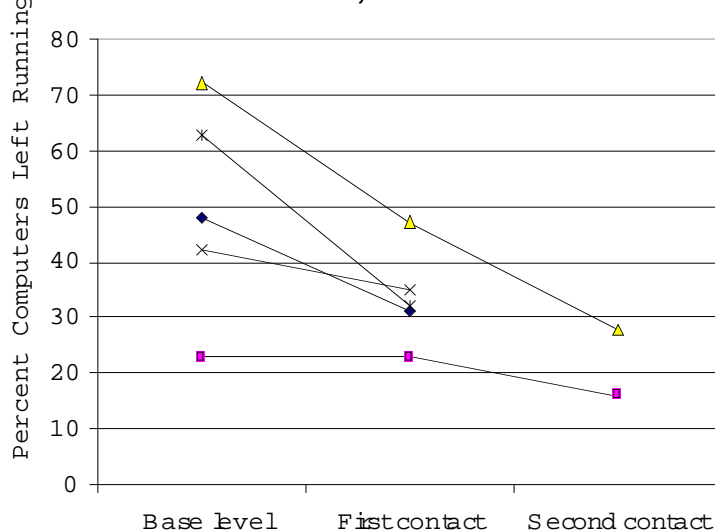
Once you have performed a series of site audits, the information can be entered into *Plugload.xls*, one sheet per site. You can reach this section of the spreadsheet by clicking on the “Research” button in the “Start Here” sheet. The authors would like to collect audit information that has been carefully gathered. If you can share audit results, please contact us through <http://eetd.LBL.gov/BEA/SF/>. A more detailed discussion of auditing is available on the web.

A Savings Example

To show the kinds of effects that a conservation program can have, we present the results from one of our experiments to reduce energy use. Figure 2 shows the change in computer user behavior during our pilot program in 1998, as a result of minimal user awareness. We sent email to people in the target departments, and placed posters on bulletin boards. The messages we used emphasized the pollution and monetary benefits of reduced electricity use, and stressed turning off equipment at night. Behavior change is significant in all cases, and is most pronounced where initial behavior was to leave the most computers operating at night. User behavior had not leveled off by the end of the test period; more improvements can be expected as the user awareness measures are continued, though long-term persistence may require ongoing

While we can't predict the lowest level of leave-on rate achievable, we did observe levels under 10% for *personal* equipment in an office with high environmental awareness, and under 5% in an office which had performed hands-on user training. A persistent program of user awareness may be able to achieve leave-on rates near these levels in most offices, and maintain it over time. Offices which require PCs to be on at night can still turn off monitors, and are prime candidates for PC power management.

Figure 2 – Equipment Left On at Five Sites, Before and After Email Contact



Our rate of success with respect to *shared* equipment is much more modest. In the best case we reduced a 100% leave-on rate to about 50%, but the success rate is not at all consistent among sites. Achieving power management configuration and auto-off (for copiers) is a more dependable conservation measure. Most of the behavioral interventions are inexpensive to implement. Even the conservation measures involving training are not expensive *if* only the provider's time is counted, not the recipients' time.

All of the estimates in this guide exclude any costs of user time, during training or waiting for equipment to return to full operation after in low-power mode or off. Any training should be kept brief to avoid using large amounts of users' time. Also, in cases in which the time to return to normal operation is large enough to interfere with work and so incur a cost, use of power management should be reconsidered. These situations exist, but are relatively rare.

Chapter 3 – Program Design

This chapter provides an overview of program design. We examine program effectiveness and costs, then outline some considerations of design strategy and finally offer a general formula for overall design. Chapter 4 addresses the program elements in further detail.

The primary **goals** of an office equipment electricity program are to: Buy ENERGY STAR equipment; Turn off equipment at night; and Configure equipment properly for power management. These are all central to achieving an energy efficient office.

The **program elements** are: Purchasing policy, Staff policy, User awareness, IS staff procedures, and Direct configuration.

The **conservation measures** are the specific actions that you choose to implement the above program elements, for example: email to staff, meetings with IS (Information Systems) managers, passage of management (governing board) resolution, presentation to purchasing department, and contracting for configuration services. Choice of measures depends on the nature of your organization, and may vary among departments.

Considering the costs of conservation measures and the rates of success that we observed, we are confident that a full program can yield a substantial fraction of the savings potential calculated in Chapter 2, and a simple payback time of less than a year (so long as the use of user time is kept minimal). We estimate that sending emails, placing posters, and making presentations at staff meetings all cost under one dollar per workstation. One-on-one training and direct configuration of PCs is estimated to cost three to six dollars per workstation. Even this would be cost-effective given the approximately \$25 potential annual benefit per station in offices such as we have in San Francisco.

Between 80% and 95% of potential savings typically occur after business hours. The best solution employs changing user behavior to turn equipment off when not needed (primarily at night), as well as enabling power management to the degree possible.

As with other energy conservation programs, a law of diminishing returns applies. Significant savings can be had with little expense by pursuing the easiest user awareness measures. On the other hand, our study observed that an intensive, one-on-one training program at one office achieved virtually all of the technical potential for user behavior. We suggest that your program design include enough followup and tracking of costs to know when you have done enough.

Especially in a governmental organization, enacting policy can be an expensive and daunting policy. Nevertheless, policy can be an essential part of an effective energy savings program, causing IS staff and others to be more responsive to other program elements.

A Comprehensive Program Menu

A comprehensive program for a large organization, with the level of interdepartmental diversity of San Francisco municipal offices will have most or all of the items below.

- **Begin Policy Process.** Begin the process of enacting purchasing and staff policies. In a large organization, the policymaking process may be lengthy but will generate interaction with IS managers and others whose assistance you will need.

- **Identify Collaborators.** Work with any existing conservation programs, such as recycling. There may already be an infrastructure of on-site conservation advocates, poster distributors, and other resources.
- **Locate Potential Savings.** Gather initial data on electricity use patterns in your organization to identify opportunities for significant (ideally easy) savings. IS staff interviews and evening walk-throughs are key sources for this information.
- **Begin Outreach Campaign.** Contacting users by the easiest methods first. Email is cheap and surprisingly effective for night turn-off. Awareness-raising is an ongoing process, and its effect builds over time.
- **Contact IS Groups.** Enlist IS staff participation where possible, and gather information by asking questions such as those in the ISStaff.doc questionnaire. You can begin this before policies are in place.
- **Prioritize Efforts.** Using information gathered in the above steps, set the emphasis for the different divisions of your organization. Take advantage of cooperative IS staff to gain early success in a few departments that can be used to demonstrate the viability of change to others. Use more expensive methods only for the areas that are not amenable to success with cheaper methods.
- **Communicate Policy.** Once policies have been enacted, summaries should be distributed to all department and IS managers, as well as those responsible for purchasing equipment or maintaining contracts for outsourced services.
- **Configure Shared Equipment.** Configuration requirements should be explicitly specified in future contracts, but might be attainable through informal agreements in the meantime. This is especially important given the difficulty of changing user behavior for shared equipment. External control devices may be appropriate for non-ENERGY STAR printers, as well as soft drink machines.
- **Followup at Selected Sites.** Perform some quick evening audits after the program has been underway for some time to judge what has been successful and what has not. If you have done pre-audits of equipment status, you will have data for direct comparison.
- **Transition to Sustaining Efforts.** The user awareness campaign may never end, though it will likely reduce to a casual operation. Replacing posters every six months, or sending an occasional email, may be sufficient. We do not have direct experience with long term program maintenance, but recycling programs have found it necessary to maintain promotional activities indefinitely.
- **Keep Aware.** New technologies and products both help and hinder the goal of reducing office equipment energy use. Keeping up with developments can help you respond to problems and pursue advantageous developments.

The best approach for program implementation will depend on the environments – physical, management, technological, cultural – of your organization. The rest of this chapter details the elements of a complete program.

Chapter 4 – Program Elements

Outline of Program Elements

In this chapter, we review each program element in detail.

- ***Purchasing.*** Ensure that efficient equipment is purchased whenever possible.
- ***Staff Policy.*** Mandate user and IS staff practices which minimize waste in office equipment use.
- ***User Awareness and Behavior.*** Change office culture and habits so that equipment is not left operating unnecessarily.
- ***Awareness and Procedures for Support Staff.*** Gain the active participation of IS staff and others in supporting the efficiency features of ENERGY STAR equipment.
- ***Direct Configuration.*** Set all ENERGY STAR equipment to correctly power manage.

The first two elements provide a management mandate for efficient operations. The third and fourth embody the main long-term thrust of transforming workplace practices. The last seeks to quickly address the problem of ENERGY STAR equipment that is not presently working as it should.

The spreadsheet *PgmCost.xls* allows estimation of the costs for various conservation measures that implement individual program elements.

Purchasing Policy

Why Purchasing Policy is Important

Even though most office equipment currently on the market is ENERGY STAR compliant, there are several reasons why a strong purchasing policy is an important aspect of any comprehensive program:

- Some equipment sold is not ENERGY STAR compliant, and there is only rarely a need to consider these models.
- The ENERGY STAR program requires that manufacturers ship equipment with power management enabled, but vendors and providers of outsourced maintenance services frequently turn it off. Your purchasing policy should require that power management be left enabled on delivery.
- The industry needs constant market pressure to maintain compliance with the voluntary program. As more large customers enact policies requiring ENERGY STAR purchasing, these pressures will be maintained.
- The ENERGY STAR office equipment program expands into new product areas as warranted. For example, scanners and multifunction devices were recently incorporated into the program.

Content and Language

The sample purchasing policies require purchasing ENERGY STAR equipment in all cases where business needs are not compromised or budget seriously affected. Included are requirements that contract vendors perform configuration, troubleshooting and maintenance services in a manner that maintains the function of power management.

The sample policies include “escape clauses” to allow the occasional purchase of specialized equipment if ENERGY STAR compliant versions are not available, or if the price differential is onerous. Wording and implementation of these clauses is important to the affected stakeholders in your organization.

Sample purchasing policy statements can be in the additional resources as *Purchase.doc* and can be found on the ENERGY STAR web site.

Making Policy Effective

To provide the broadest support, these policies should be enacted at the highest level possible. Then, follow-up work should make the new policies well known to all affected.

- Distribute copies of the adopted policy statements to all staff engaged in purchasing or contracting. A concise executive summary should be on the cover page.
- Arrange for staff with purchasing roles to receive training in ENERGY STAR purchasing, including the details of adopted policy, resources available for assistance, and any organization-specific issues.
- Prepare materials to assist contract vendors with compliance, and for vendors to disseminate back to departmental contacts. Interview vendor representatives to make sure their service personnel are aware of contract requirements concerning power management.
- Depending on the degree of oversight inherent to the purchasing process, it may be prudent to perform some ‘spot-checking’ to confirm acceptable implementation of purchasing policies.

Staff Policy

Staff policy should ask employees to always turn off their equipment at night unless there is a particular reason not to do so. IS staff should similarly be directed to always enable power management (with reasonable delay times) unless it interferes with the functioning of the equipment. This is especially important for policies that affect IS staff (Information Services personnel are accustomed to providing direction, rather than following the mandate of others.) It is essential that official policy adds energy conservation to the list of core IS issues, so that power management is considered one of the base features maintained in the computer stock. IS staff are more likely to follow policy direction handed down from above than act on a request by “outsiders” such as energy professionals.

As with purchasing policy, mandates governing staff behavior and IS staff procedures must be enacted at the highest level possible, so that there is no question that management supports the effort. For policies to be effective, an education campaign is needed. The purpose of these policies is mainly to strengthen the effectiveness of your user awareness campaign and to gain support of IS staff.

Sample policy statements can be found in the additional resources as *Staffpol.doc*.

User Awareness

This program element seeks to impart an energy conservation ethic in the workplace, as recycling programs do with respect to materials conservation. Policy can be used to strengthen user education efforts.

Goals and Approach

An effective awareness campaign must have visibility and persistence, imparting several messages, through several channels. The variation of messages, and changes in their presentation, keeps the promotional materials from becoming too familiar and thus less visible (see Appendix E on the web for more on this topic). Your communications with staff will:

- Emphasize the environmental advantages of power management. Make the link to environmental goals, such as greenhouse gas reduction.
- Highlight the monetary advantages of power management. Educate users about energy efficient policies and practices, and the connection to the organization's bottom line expenses.
- Dispel myths about equipment damage from on-off cycles.
- Describe basic power management features.
- Discourage the proliferation of user-supplied personal appliances.
- Answer questions about these issues as they arise.

Channels of Communication

Following are some of the methods for conveying the above messages to office staff:

- **Emails.** Send email messages to each person. These should not be sent so often as to be annoying, but several messages within the first year of the program is reasonable.
- **Posters.** Create and distribute a series of posters and place them prominently on bulletin boards, break rooms, over copy machines. Colorful designs catch the eye, and simple messages can reinforce the content of emails.
- **Staff Meeting Presentations.** These are best done within a regular meeting, not as a special, extra meeting. This forum allows you to answer questions on the spot, as well as allowing the group's manager to voice support, and personalize the message. As more expensive than emails, these should first be conducted in areas without easy email access.
- **User Training.** A training sessions for users covers detailed aspects of power management, including why to use it and how to configure machines. This is the most expensive measure, though also apparently the most effective. Including staff time for the recipients, the cost would probably not be justified by energy savings. However, there may be other reasons to train users, such as integration of new computers or software, or data security concern, and power management could be incorporated into it.
- **Direct Configuration.** In the course of direct equipment configuration, those who perform these operations can also explain it to users. This one-on-one contact is particularly effective.
- **Existing Resources.** Identify existing organization-wide environmentally-oriented outreach programs, such as recycling. These will have developed channels of communication; you may wish to communicate jointly or obtain their contact list for independent communications. Particularly valuable is any existing network of conservation advocates within offices. Find out if this network can be used for the office equipment program.
- **Informational Resources.** Establish these to answer questions as they arise. Include a contact telephone number, email address, Internet/intranet web page, and resources from EPA and manufacturers.

- **Other Routes.** These include arranging for notes to be distributed with employee paychecks. We are reluctant to do this if less resource-intensive methods are able to reach the majority of employees. In most organizations this method would have the advantage of reaching every employee, and could convey a message directly from the top-level leader about official conservation policy.

Sample promotional materials are included in the additional resources. Included are text for email messages, posters, and web pages.

Information Systems Staff Assistance

This program element is highly dependent upon the nature and structure of your IS staff. The goals are to:

- Educate IS staff about power management: the various systems affected, configuration details, troubleshooting, and common problems.
- Dispel myths concerning possible damage due to turning equipment off.
- Find the most cost-effective methods for configuring and maintaining power management.
- Gain assistance reaching users through intranet web sites and network broadcast messages.

The intent is that IS staff will be motivated to take aggressive action to enable ENERGY STAR features — they will visit all the machines and reconfigure them as a special task. A more likely outcome is that they will incorporate power management configuration into their normal maintenance procedures.

The message you are trying to convey to IS staff includes the awareness issues listed for the user population, plus technical issues about power management and the request for IS staff services:

- Routine checking and configuration of power management adds little to their installation or maintenance of a machine.
- Power management configuration should always be checked when a new machine comes in.
- Monitor power management won't interfere with PC function. If it is necessary to disable PC power management, it is important to maintain power management of the monitor.
- Management policy supports power management and equipment turn-off.

It may be sufficient to meet with IS management groups and talk to individual IS staff on the phone. The amount of effort depends on the degree of cooperation you encounter. Some groups may be so difficult to work with so you may decide to abandon IS help and rely on improved user behavior.

For the IS groups that show a low level of knowledge concerning power management issues, you may want to carry out a series of training sessions. It may be most appropriate for a consultant to conduct these sessions; many IS staff are skeptical of technical advice offered by non-IS people such as from energy offices.

Finally, monitor the process of implementation and provide assistance as needed. Not everyone who sounds cooperative will actually take the requisite actions. Attempt to address issues the IS staff raise, making use of vendors' and manufacturers' technical assistance, and literature from EPA. Gather information about technical issues, particularly those common in your organization.

Direct Configuration

If power management has been disabled on a large percentage of the equipment, it can be most effective to systematically reconfigure it. Direct configuration refers to efforts that are focused on power management and address all equipment systematically. This is in contrast to IS Staff Assistance which aims to make power management enabling part of the larger system maintenance, and reaches machines whenever the IS staff get to them. The people best suited to this task are IS staff, as they are most familiar with the equipment and users, and any legitimate reasons to not enable it. They will also be most likely to know any needed passwords, or have the necessary keys for locked doors. For many organizations, or for some departments within complex organizations, the level of IS support is insufficient to perform wholesale reconfiguration of equipment. For power management to be enabled in a reasonable amount of time, you may need to get it done independently.

Direct configuration should be avoided when enabling rates are already high. For PC enabling, it is best to concentrate on those models of computers that are common in the office. Begin by enabling one of each model and testing it to make sure power management does not interfere with proper functioning. For each model that passes that test, enable the rest of that model.

This intervention can be done cost-effectively if prior work has been done to gain management support. Reconfiguration of equipment can be done during the daytime or after hours. In the first case, the person performing the task will be interrupting users, but gains the opportunity to educate them first hand. After hours, reconfiguration can be done in less time per station but may require log-on passwords for access.

Our success with the reconfiguration of computers was mixed. Information Systems staff at two of the five sites agreed to check the configuration of their computers and see that power management is enabled. At one of these sites the configuration was confirmed to have been done. At a third site, IS staff were minimally responsive but did not impede our efforts to manually reconfigure equipment. At the other two sites, IS staff were completely unresponsive; in one, management did not allow us to directly reconfigure computers.

We expect that the presence of organization-wide policy will elicit better cooperation from IS staff and departmental management. However, some difficulties may persist. Where IS staff are cooperative, direct configuration is a cheap and effective program element, but where IS staff are difficult to work with the reverse may be true.

Copiers and fax machines are usually not under the purview of IS staff, so it may be necessary to go to each site and configure them yourself. If this equipment is leased, you may be able to get the vendors to agree to check the configuration as they perform routine maintenance. As there is little danger of causing problems, direct configuration of these by non-IS staff is a low-risk proposition.

External Power Management Hardware

Devices are available that automatically control plug loads based on user activity. Originally devised to allow power management in pre-ENERGY STAR computer monitors, these now include cubicle occupancy controls to switch task lights and other loads. There are also automatic controls for older printers and for vending machines. Many ‘controlling device’ manufacturers are ENERGY STAR partners.

The advantage of these devices is that they require almost no configuration. Normally there is only a delay timer setting. There is no question of interference with normal machine function,

unless a computer is inadvertently plugged into a controlled outlet. We installed a handful of devices from the leading manufacturers and found them to work dependably. Prices per unit range of \$30 to \$80 for workstation occupancy devices, and \$150 to \$200 for printer and vending machine controls. We found these to be less cost-effective than manual turn-off and enabling power management. An exception is the vending machine controls for which there is no competing strategy.

These devices are worth considering if institutional barriers prevent implementation of the recommended program elements. Careful consideration should be given to the lifetime of controlled equipment. The most likely case where cubicle occupancy controls are cost-effective is in cubicle systems incorporating several task lights.

For workers with several computers, or for server rooms, consider switching devices that allow one monitor to service many computers. These not only save electricity, but also the larger costs of purchasing the monitors and office space.

Extraneous Devices

Of the “miscellaneous” plug load, the devices which may significantly raise electricity use are those with long operating hours: refrigerators, coffee pots, heaters, and fans. Intermittent-use devices such as toaster ovens and hot plates may be of concern for building wiring or fire safety, but not for energy use. Coffee pots, because they are often left on all day, can use considerable energy. Offices should be encouraged to purchase thermos coffee dispensers, which not only save energy but result in better tasting coffee — and less thrown out due to overheating.

Some individual fans and heaters found in offices are likely ‘unnecessary’, but when many are found in a building, it usually signals inadequacies in the ventilation system. If it is possible to get the system fixed, then managers can ask to have the fans and heaters removed. An energy conservation program should not take on such devices where working conditions are inadequate.

If there are many private-use refrigerators, this may be due to inadequate kitchen facilities, and increasing them may be appropriate.

Paper Use

Just as modern office equipment wastes considerable electricity, the way that paper is used in printers, copiers, and fax machines often wastes considerable paper. This in turn costs money, and wastes the energy used to produce the paper. The same types of measures that are used to reduce electricity use are also the basis of reducing paper use. See <http://eetd.LBL.gov/Paper>.

Chapter 5 – Summary

This Guide has reviewed the essential elements of a program to reduce office equipment energy use. You should now be able to assess what type of effort is appropriate and feasible in your organization.

The first step—addressed in Chapter 1—is understanding the scope and magnitude of electricity use of office equipment, and the primary factors that affect it. The presence of ENERGY STAR equipment in your office means that you are likely to be already saving significant electricity, whether or not the procurement of ENERGY STAR compliant equipment was deliberate. The primary methods of gaining additional savings are better user behavior (turning off equipment at night), enabling of power management features, and more attention to purchasing ENERGY STAR compliant equipment.

Chapter 2 discusses several methods for estimating the size of your “plug load” and the potential for additional savings from a program. The simplest estimate is an extrapolation from what we found in San Francisco municipal offices based on the relative number of employees. More refined estimates adjust for your equipment holdings, night-time turn-off behavior, and enabling of power management. These require some amount of “auditing” of equipment and its usage.

Overall program strategy and design is reviewed in Chapter 3. This is divided into five “program elements”, which are each implemented by one or more specific “conservation measures”. The overall composition of your program is likely to evolve over time as you discover unexpected opportunities, allies, or obstacles.

Finally, Chapter 4 contains more detailed discussion of the five main program elements. Purchasing Policy ensures that ENERGY STAR compliant equipment is procured to the maximum feasible extent. Staff Policy establishes a ‘norm’ of the use of power management and night-time turnoff (except in cases where there is a specific reason not to use them); the policy is founded on support from management at the highest level attainable. User Awareness efforts communicate the importance of reducing plug load electricity use for reducing pollution and costs, and of the methods for doing this. Information Systems Staff Assistance engages those people who most influence the enabling or disabling of power management and serve as a source of advice for most users. Finally, Direct Configuration involves the implementers of a program enabling equipment themselves, with or without the involvement of users. While most appropriate for printers, copiers, and fax machines, this is often the simplest and most reliable way to gain savings.

Chapter 4 also covers additional topic areas that can be addressed in a comprehensive program. One is External Power Management Hardware, which can be purchased to accomplish power management in devices that otherwise do not have that capability; in some circumstances they can be useful and cost-effective. Another issue is “Extraneous Devices” that serve personal needs and may be possible to eliminate by addressing the need they are a response to such as a poorly functioning ventilation system. Finally, Paper Use is a method to save energy, save money, and reduce pollution that is often unrecognized, but holds significant opportunity.

Glossary

Advanced Configuration and Power Interface (ACPI)

ACPI is a new standard method for parts of the computer and peripherals to identify themselves and accomplished sophisticated power management. While the power capabilities are most applicable to portable equipment, they also offer the capability to significantly increase power management savings in desktop equipment.

Annual Energy Use

The amount of electricity (in kWh) used by a piece of office equipment.

APM (Advanced Power Management)

APM is a standard that defines mechanisms by which the processor controls power use by various system components while the system is in active use (see Intel/Microsoft, 1993 for further details).

Auto-off, Automatic Shutoff

For copiers, Auto-off is a feature that causes the copier to switch entirely off after a period of non-use, or based on a prespecified turnoff time.

BIOS (Basic Input/Output System)

The BIOS is the interface among the processor, cache and main memory and system busses which lead to add-on cards and some external peripherals, and also controls the initial stages of system start-up. The BIOS is a key element in most implementations of power management.

Configuration

The settings in the equipment which, in the context of this guide, determine whether and how power management will occur. For computers, this is done in the BIOS (above) and the operating system. For other devices the settings are usually made with a keypad and a menu system.

Daytime Savings

Savings occurring during periods of inactivity during normal business hours.

Default Duplex

The ability for a copier or printer to make double-sided copies as the default mode.

Doze

The doze mode is the first level of PC power management. The system clock slows or even halts.

DPMS (Display Power Management Signaling)

DPMS defines four power management modes for monitors: On, Stand-by, Suspend and off. The presence or absence of particular (horizontal and vertical) synchronization signals or the entire video signal indicate to the monitor which power management mode to enter.

ENERGY STAR

The ENERGY STAR program was created by the U.S. Environmental Protection Agency to encourage the manufacture and use of office and other equipment that reduces energy use and hence pollution from power plants.
<http://www.epa.gov/office>

External Control Hardware, 'Controlling Devices'

A device that can turn a piece of office equipment entirely off when it determines that it is not active.

Impact Printer

A printer employing inked ribbon and mechanical impact to print characters, like an electric typewriter. These are usually found on mainframe systems and may be very large with high speed capacity.

Information Systems (IS) Staff

The personnel in an organization that maintain the hardware and software infrastructure of computers, printers, networks, etc.

Inkjet Printer

A printer which uses microscopic jets of liquid ink to product an image. These are usually small, low-speed printers that can print color images. They use much less power than laser printers.

Laser Printer

A printer using a laser light source, a high-voltage electrostatic process and a high-temperature sealing roller to make high quality images using a dry toner. The high voltage supply and heat roller require a high power draw during the imaging process.

Low Power Mode

A state that a device can enter in which it consumes less power than the standard operating mode, but is not off.

Mainframe Terminal

A keyboard and video display device having no stand-alone computing power, which is used to communicate with a mainframe computer.

Memorandum of Understanding (MOU)

The agreement between office equipment manufacturers and the U.S. EPA on the criteria that ENERGY STAR compliant products must meet, and the actions that each party will take to promote the program and compliant products.

Monitor

The monitor for a PC is usually a cathode ray tube (CRT), and serves to display visual information. ENERGY STAR monitors are able to enter low power modes of operation, but require signals from the PC to do so.

Multi-function Device (MFD)

A combination printer and fax machine, commonly used in small offices. The print engine may be inkjet or laser.

Nighttime Savings

Energy savings occurring after normal business hours. This includes weekend, holiday and vacation days as well.

Office Equipment

Electronic devices for managing information, including (but not limited to) computers, monitors, printers, copiers, scanners, multifunction devices, and fax machines.

Personal Computer (PC)

In this guide we generally use "PC" to refer to the processor and related hardware (that is, excluding external disks, printers, etc.), and not including the monitor. Sometimes "PC" refers to the entire system, but it should be clear from the context when this is meant. "Computer" power management includes PCs and monitors, as well as workstations.

Power, Energy

Instantaneous electricity use (power) is measured in Watts (W), with the amount of electricity used over time typically measured in kilowatt-hours (kWh).

Plug Load, Office Plug Load

Electricity used by devices connected to ordinary electrical outlets. Examples for offices include office equipment, task lights, water coolers, and kitchen appliances.

Power Management (PM)

Power management uses firmware, hardware and software solutions to conserve energy when the computer sets idle and enters defined states of inactivity.

Shared Device

An office device commonly used by more than one person, such as a copier, fax machine, or printer.

Sleep Mode, Standby Mode

Sleep and Standby are the first low-power stages that turn down or turn off some peripherals and allows for almost immediate recovery.

Suspend Mode

The lowest powered mode for a PC. As many system components as possible are powered down, and the processor is halted.

Workstation

A computer and monitor.

Bibliography

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Koomey, Jonathan G., Mike Cramer, Mary Ann Piette, and Joe H. Eto, *Efficiency Improvements in U.S. Office Equipment: Pollution Prevention at a Profit*, American Council for an Energy Efficient Economy Proceedings, 1996, p. 5.123. See web location below.

Nordman, Bruce, Mary Ann Piette, Brian Pon, and Kris Kinney, *It's Midnight...Is your Copier On?: ENERGY STAR Copier Performance*, Lawrence Berkeley National Laboratory publication 41332, 1998. See web location below.

Koomey, Jonathan, Timothy Oey, and Eric Bergman. 1993, "The Economics of Cycling Personal Computers." *Energy Policy*. vol. 21, no. 9. September. pp. 937-943.

Other Resources

Mark Ledbetter and Loretta A. Smith; *Guide to Energy-Efficient Office Equipment*, American Council for an Energy-Efficient Economy, 1996

Nordman, Bruce, Mary Ann Piette, Kris Kinney, and Carrie Webber, *User Guide to Power Management for PCs and Monitors*, Lawrence Berkeley National Laboratory publication 39466, 1997. See web location below.

Web pages

EPA ENERGY STAR Office Equipment — <http://www.epa.gov/office> – Information about the Energy Star Office Equipment Program.

Federal Energy Management Program – <http://www.eren.doe.gov/femp> — Guidelines and information targeted at Federal facilities.

Purchasing Guidelines (FEMP) – <http://www.eren.doe.gov/femp/procurement/begin.html> – Recommendations for Energy Efficiency – ENERGY STAR and beyond.

Purchasing Language — http://www.epa.gov/appdstar/esoe/pdf/proc_lan.pdf – Information about the Energy Star Office Equipment Program.

Reducing Office Equipment Energy Use. <http://eetd.LBL.gov/BEA/sf/> Updates of this guide and additional resources.

“Cutting Paper” web site, <http://eetd.LBL.gov/Paper> Information about how to understand office paper use and reduce it.

“User Guide”, *User Guide to Power Management for PCs and Monitors*, <http://EETD.LBL.gov/EA/Reports/39466/>

Copier Report, <http://EETD.LBL.gov/EA/Reports/41332.html>

U.S. Office Equipment, <http://enduse.lbl.gov/Info/Pubs.html> (under 1995 reports)

Appendix – Additional Resources

The computer files listed below facilitate the work described in this guide and are available for downloading. The spreadsheets (.xls, .xlw) are in Microsoft Excel 5.0/95 format, and the word processing files (.doc) are in Microsoft 95/97 format. The posters are in Microsoft Powerpoint format.

Computational Tools

Plugload.xls – calculates annual electricity use, and potential savings
PgmCost.xls – calculates the cost of program implementation methods
Controls.xls – calculates savings from office occupancy controls

Sample Policies

Purchase.doc – purchasing policy
Staffpol.doc – staff policy

Survey/Audit resources

ISSurvey.doc – interview questions for IS managers and staff
OfSurvey.doc – interview questions for office managers and staff

Promotional messages

Email1.doc, Email2.doc – sample email messages
Poster1.ppt, Poster2.ppt – sample posters.
Handout.doc – handout flyer for configuration visits

Web page

Ofmach.htm – web page and graphics, describing program and how to perform Windows 95 monitor power-down configuration.

Updated versions of this guide and additional resources are available at
<http://eetd.LBL.gov/BEA/SF/>.